SFSL Internship Exit Presentation

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Internship Outline

- 10 Week Internship to support the SFSL

ISS:

- **Develop a versatile dairy sauce that can become a base for multiple dairy-based freeze dried food applications**
  - The complex must rehydrate easily in warm water and result in a creamy mouth feel
  - Final demonstration of the complex should be performed in at least 2 freeze dried products

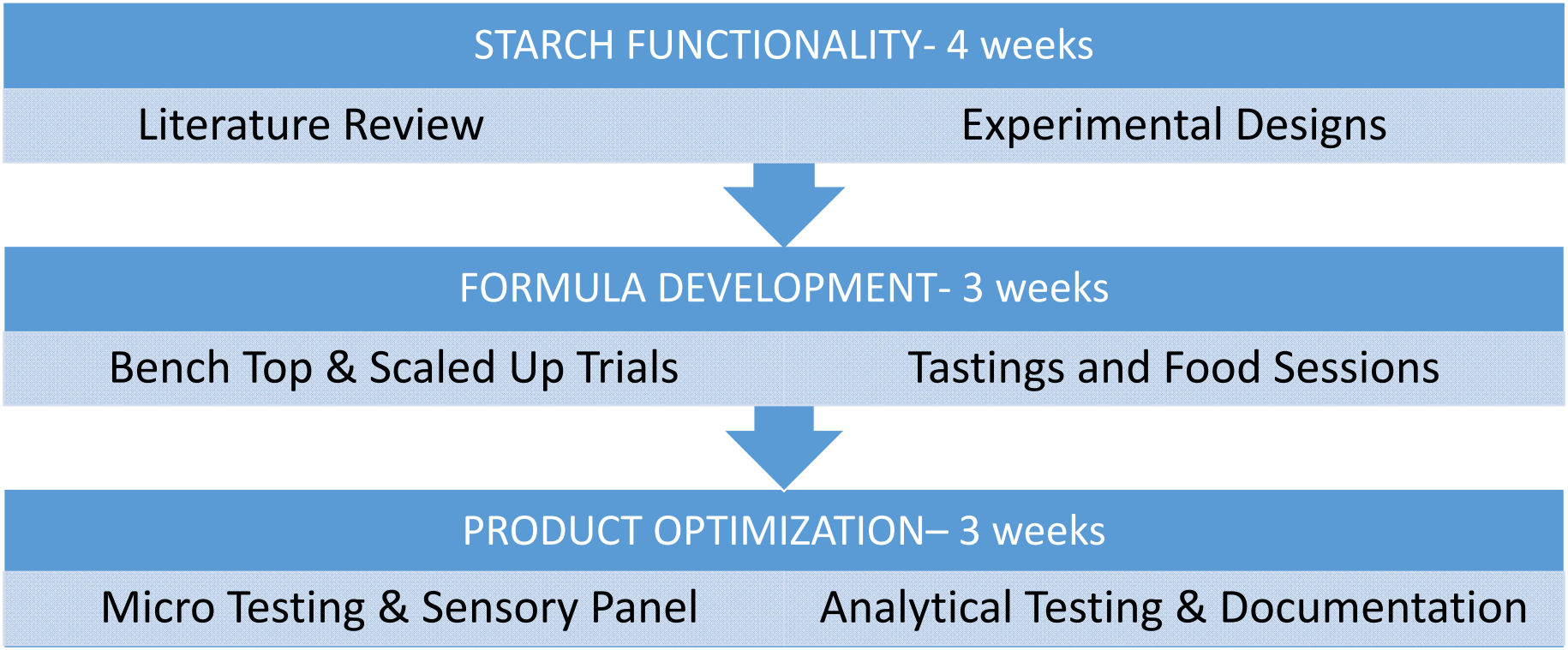
AFT:

- **Conduct a literature review on the bioavailability of Vitamin A, K, B5, B6, B7, B9, B12, Potassium, Selenium, Zinc, Manganese, Copper, Iron**
  - Review current scientific literature on bioavailability of nutrients and how they are affected by form, ingredient interactions and processing conditions
  - Characterize the conditions that reduce or improve bioavailability of nutrients for future food development

ISS Project Background

- A reformulation to reduce sodium has led to rehydration issues with cream of mushroom soup
- The cream base of the beef stroganoff had room for improvement
- Dairy based sauces are missing from the current menu

Project Timeline



Starch Functionality

- **25 starches were screened as a dairy based roux**
  - Rehydratability- NO Clumps!
  - Flavor
  - Color
  - Texture

Starch Functionality

- **Focused initially on commercial ingredients then widened to industrial ingredients**

- **Ingredient interactions were also screened based on literature review learnings**
  - Impact of protein
  - Impact of form: solid brick vs powdered
  - Impact of hydrocolloids and dispersants

Starch Screening – Trial 1

- Initial screening of starches found at HEB

Starch Functionality	Color	Flavor	Rehydration	Texture	Proceed
AP Flour					
Bread Flour					
Tapioca Starch					
Potato Flour					
Flour + Whey Protein					
Garbanzo Bean Flour					
Corn Starch					
Potato Starch					

Starch Screening – Trial 2

- Screening of additional store purchased starches
- Reduction of fat
- Further understanding of native tapioca processing limitations >155 F= gelatinization

Starch Functionality	Color	Flavor	Rehydration	Texture	Proceed
Wondra Thick					
Wondra Thin					✓
Wondra Roux					
Tapioca Starch					✓
White Rice Flour					
National 465 - Mod Corn					

Starch Screening – Trial 3

- Screening of commercial starches from Ingredion
- Refinement of processing parameters and hydration rates
- Food showing to gather feedback on next steps: Optimize with Ultra Sperse M

Starch Functionality	Color	Flavor	Rehydration	Texture	Proceed
Ultra Sperse M -Cold					
Tapioca Starch - BRM				Gritty	
Ultra Sperse M - Hot					✓
Ultra Sperse 3					
Wondra Thin					

Starch Screening – Trial 4

- Focused on one starch base: Ultra Sperse M (Modified Corn Starch)
- Investigated the impact of the addition of hydrocolloids
- Investigated the feasibility and impact of pulverizing dry soup prior to packaging to reduce clumping

Starch Functionality	Color	Flavor	Rehydration	Texture	Proceed
Ultra Sperse M - Skim					
Ultra Sperse M - Mootopia					
Novation 3600					
Ultra Sperse M - MD2 Malto					✓
Ultra Sperse M - CA1 Malto					✓
Ultra Sperse M - HPMC					
Ultra Sperse M - Carrageenan					
Ultra Sperse M - Xanthan					
Ultra Sperse M - Gellan					
Ultra Sperse M - Cellulose					

Starch Functionality: Overall findings

- Addition of protein did not positively impact hydratability
- Impact of pulverization did not provide enough improvement to offset the added complexity and risk
- Addition of maltodextrin improved the overall texture and rehydratability of the sauce
- Of store purchased starches, tapioca is the best for this application although industrial starches are more robust and provide better texture

FORMULA DEVELOPMENT

- **Incorporated the dairy base into 3 freeze dried meals**
  - Cream of Mushroom Soup
  - Beef Stroganoff
  - Angel Hair Alfredo

Formula Development

- **Participated in Food Sessions, Bonus Sessions and Debriefs**
  - Flavor and texture profile of current ISS menu
  - Hydration and serving constraints of Zero gravity
  - Flavor profiles that the astronauts like
  - Opportunities to improve perceived flavor with low sodium items (spice/pepper/ garlic)

https://twitter.com/Astro_Sabot

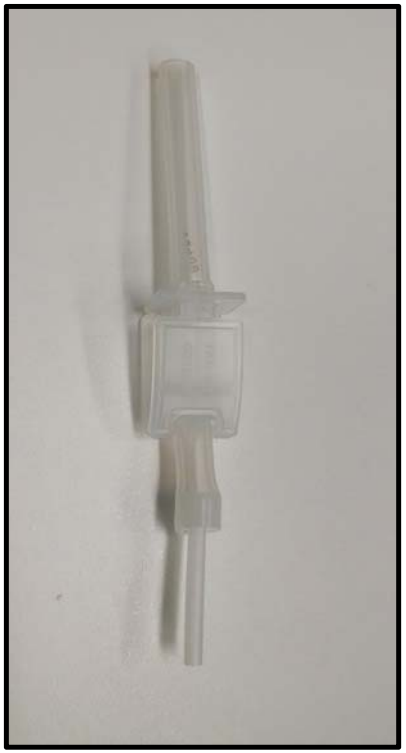
Cream of Mushroom Soup Development Goals

- **Increase flavor intensity without added sodium or replacers**
  - Shift to a white pepper spice profile
  - Increase the mushroom intensity
  - Added mushroom concentrate for added umami without sodium

- **Improve the texture**
  - Increase rehydratability of the base
  - Investigate modifications of both form and formulation
  - Look to increase the viscosity enough to allow it to be spoonable out of an EDO vs. sipped through a straw

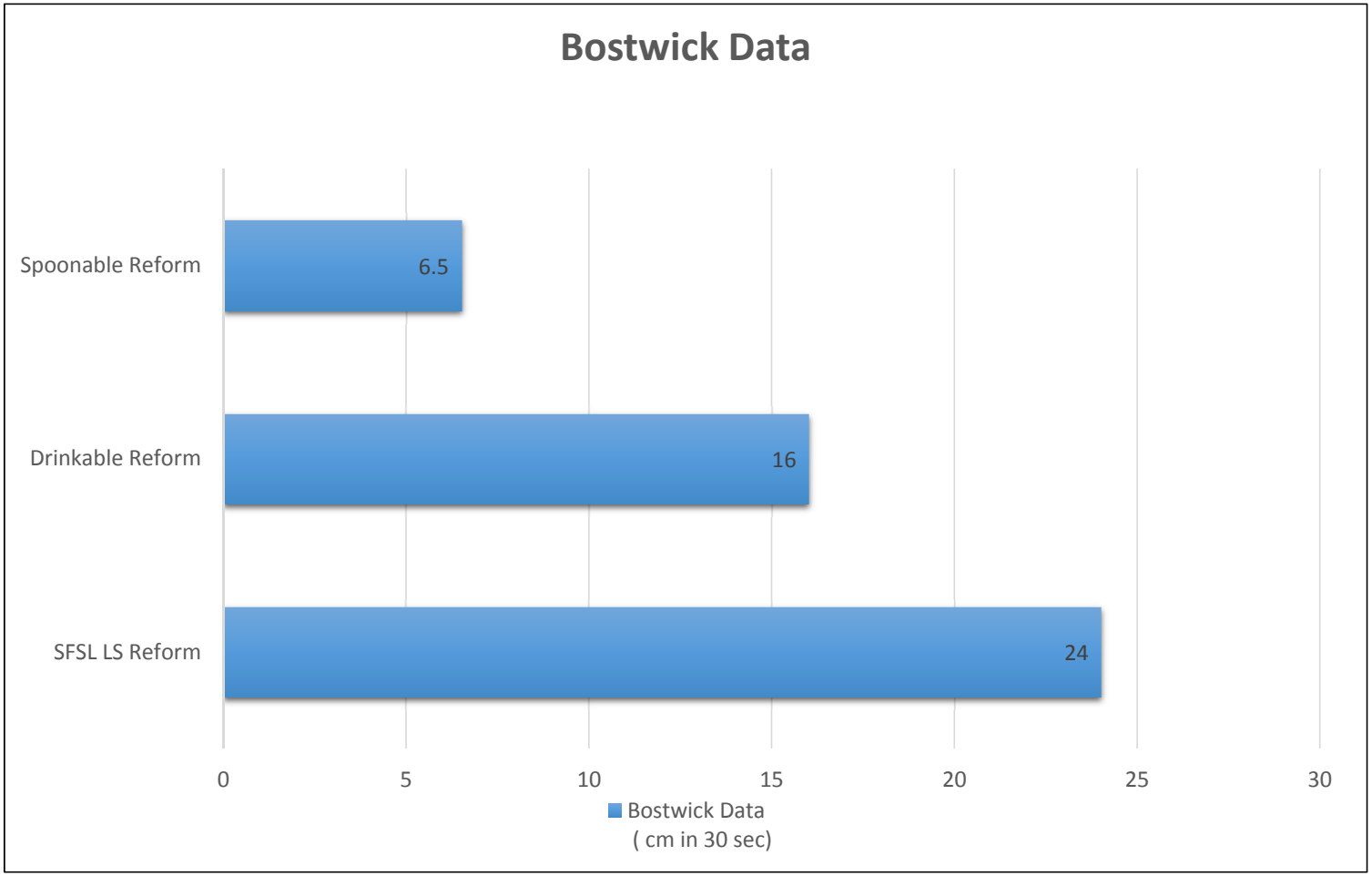
Soup Trial 1

Soup Viscosity

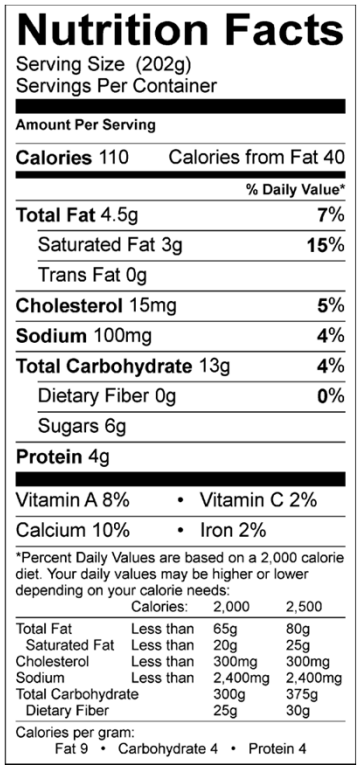


Increasing viscosity

Viscosity Data



Cream of Mushroom Nutrition



Nutrition Facts

Serving Size (202g)
Servings Per Container

Amount Per Serving

Calories 110	Calories from Fat 40
	% Daily Value*
Total Fat 4.5g	**7%**
Saturated Fat 3g	**15%**
Trans Fat 0g	
Cholesterol 15mg	**5%**
Sodium 100mg	**4%**
Total Carbohydrate 13g	**4%**
Dietary Fiber 0g	**0%**
Sugars 6g	
Protein 4g	

Vitamin A 8% • Vitamin C 2%

Calcium 10% • Iron 2%

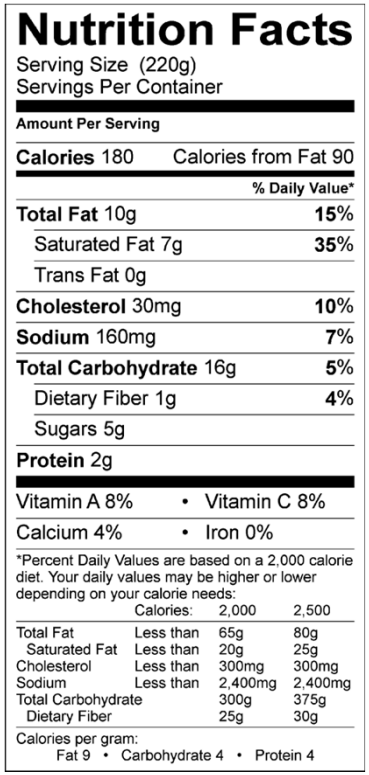
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Water– 53%
Half & Half- 32%
Mushroom- 6%
Butter 3%
Flour- 3%
Mushroom Base- 3%

ORIGINAL SFSL FORMULA



Nutrition Facts

Serving Size (220g)
Servings Per Container

Amount Per Serving

Calories 180	Calories from Fat 90
	% Daily Value*
Total Fat 10g	**15%**
Saturated Fat 7g	**35%**
Trans Fat 0g	
Cholesterol 30mg	**10%**
Sodium 160mg	**7%**
Total Carbohydrate 16g	**5%**
Dietary Fiber 1g	**4%**
Sugars 5g	
Protein 2g	

Vitamin A 8% • Vitamin C 8%

Calcium 4% • Iron 0%

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	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Puréed Mushrooms- 36%
Vegetable broth- 29%
Skim milk – 14%
Onions- 8%
Butter- 6%
Thickeners- 4%
Mushroom Base- 2%
Spices- 1%

REFORMULATION

Cream of Mushroom Soup Next Steps

Task	Accomplished	Outstanding
Formula Development	✓	
Nutrition Panel Creation	✓	
Scaled Up Trial	✓	
Draft Specification	✓	
Sensory Testing		✗
Formula Optimization		✗

Beef Stroganoff Development Goals

- **Increase flavor intensity without added sodium or replacers**
  - Shift to a more complex spice profile
  - Increase the dairy profile
  - Add mushroom concentrate for added umami without sodium

- **Improve the texture and satiety**
  - Increase rehydratability of the base
  - Look to improve the creamy texture of the sauce
  - Proof of process of dairy base for multiple formulations

Beef Stroganoff Nutrition

Nutrition Facts

Serving Size (35g)
Servings Per Container

Amount Per Serving

Calories 150 — Calories from Fat 50

% Daily Value*

Total Fat 5g — 8%
Saturated Fat 2.5g — 13%
Trans Fat --g
Cholesterol 20mg — 7%
Sodium 135mg — 6%
Total Carbohydrate 18g — 6%
Dietary Fiber 1g — 4%
Sugars --g
Protein 10g

Vitamin A --% • Vitamin C --%
Calcium 2% • Iron 8%

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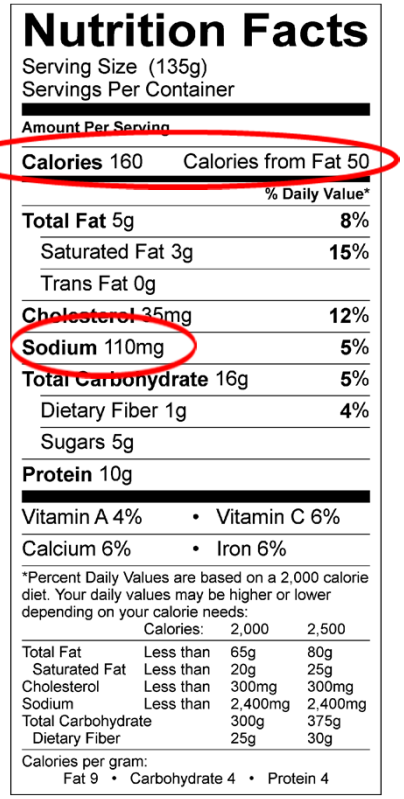
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Beef– 26%
Beef Broth -24%
Kluski Noodles- 20%
Onions- 12%
Sliced Mushrooms- 7%
Sour Cream-5%
Unbleached Flour- 3%
Butter- 2%
Oil and Spices- 1%
- Salt
- Black Pepper

CURRENT SFSL FORMULA



Nutrition Facts

Serving Size (135g)
Servings Per Container

Amount Per Serving

Calories 160 — Calories from Fat 50

% Daily Value*

Total Fat 5g — 8%
Saturated Fat 3g — 15%
Trans Fat 0g
Cholesterol 35mg — 12%
Sodium 110mg — 5%
Total Carbohydrate 16g — 5%
Dietary Fiber 1g — 4%
Sugars 5g
Protein 10g

Vitamin A 4% • Vitamin C 6%
Calcium 6% • Iron 6%

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Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Beef– 21%
Beef Broth -3%
Kluski Noodles- 22%
Onions- 11%
Sliced Mushrooms- 13%
Light Sour Cream-16%
Skim- 8%
Thickeners- 2%
Butter- 2%
Spices- 2%
- Mustard
- Dill
- Black and White Pepper
- Pear Vinegar
- Liquid Aminos
- Garlic

REFORMULATION

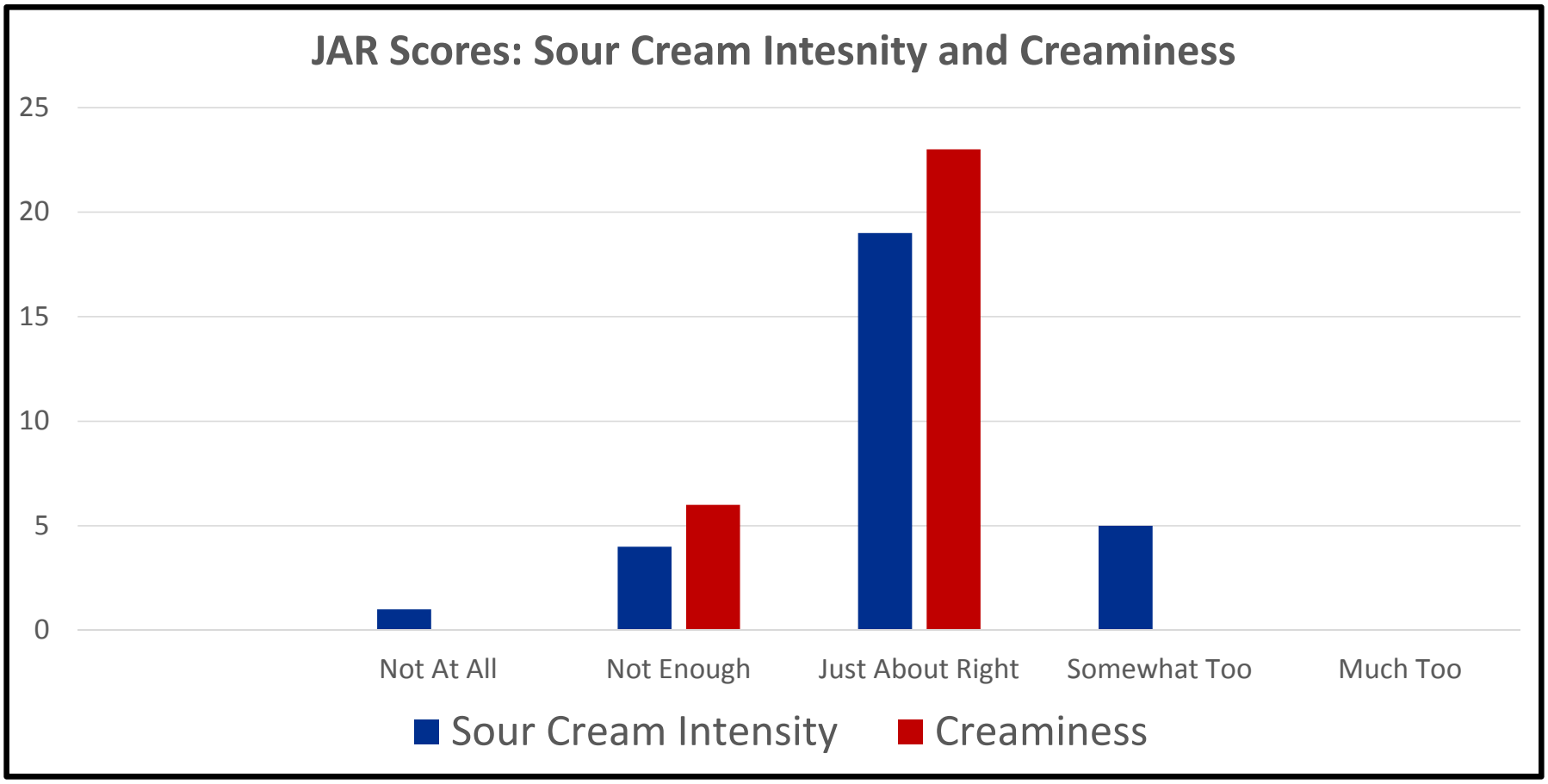
Sensory Results

- 35 gram sample hydrated w/ 75ml 150°F +/- 5 °F
  - Sensory score 6.03
  - SD 1.86
  - n=29

Panelist Feed Back

- **Beef Texture**
  - 45% of panelists disliked the tough beef texture and issues with meat hydration
- **Cream Sauce**
  - Sauce texture and ratio was well received
  - Sour Intensity seemed just about right – 66%
  - Creaminess seemed just about right – 79%
- **Seasoning**
  - Seasoning was well received
  - If changes are made increase intensity keeping similar profile

JAR Scores- n= 29



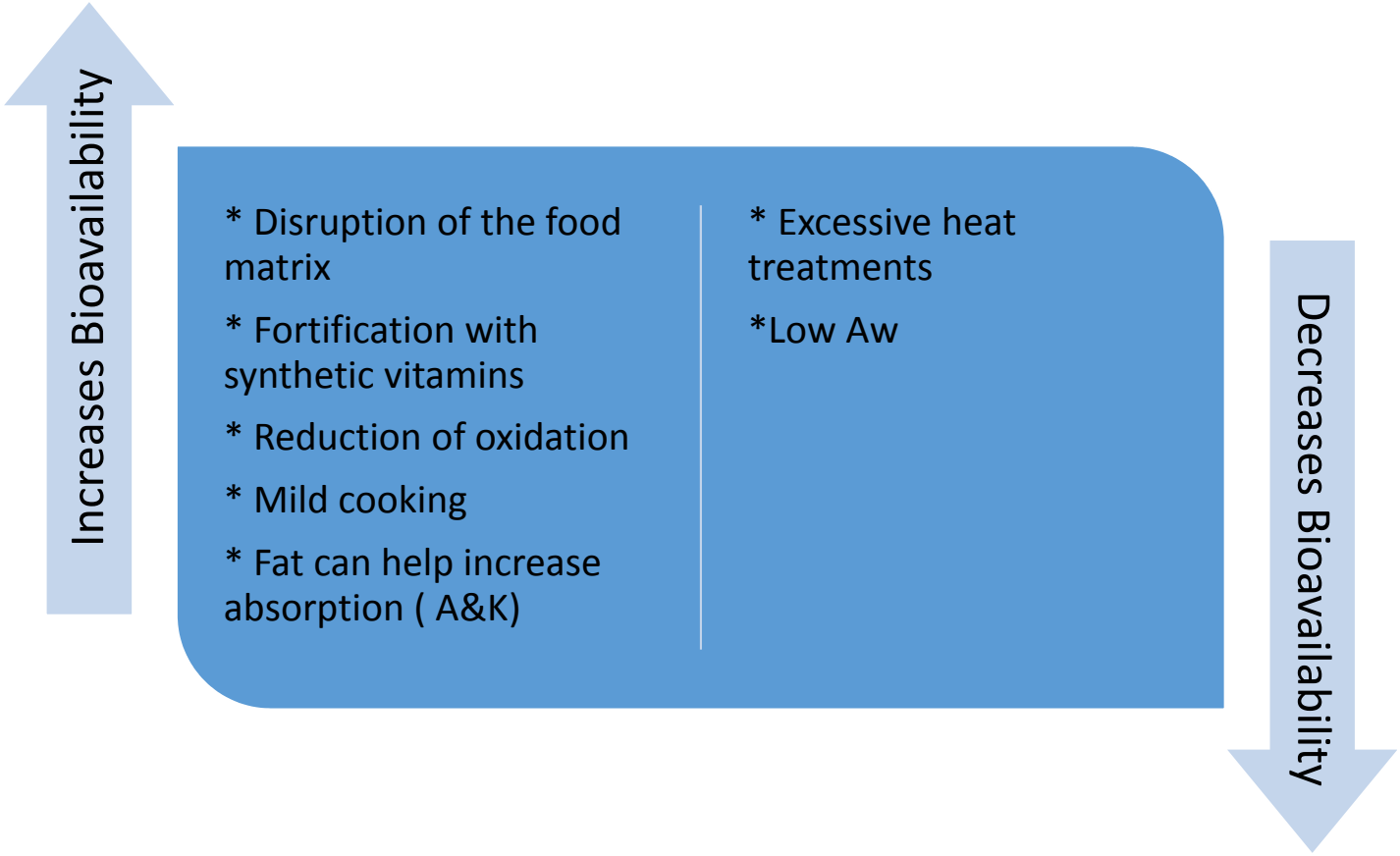
Beef Stroganoff Next Steps

Task	Accomplished	Outstanding
Formula Development	✓	
Nutrition Panel Creation	✓	
Scaled Up Trial		✗
Draft Specification	✓	
Sensory Testing	✓	
Formula Optimization		✗

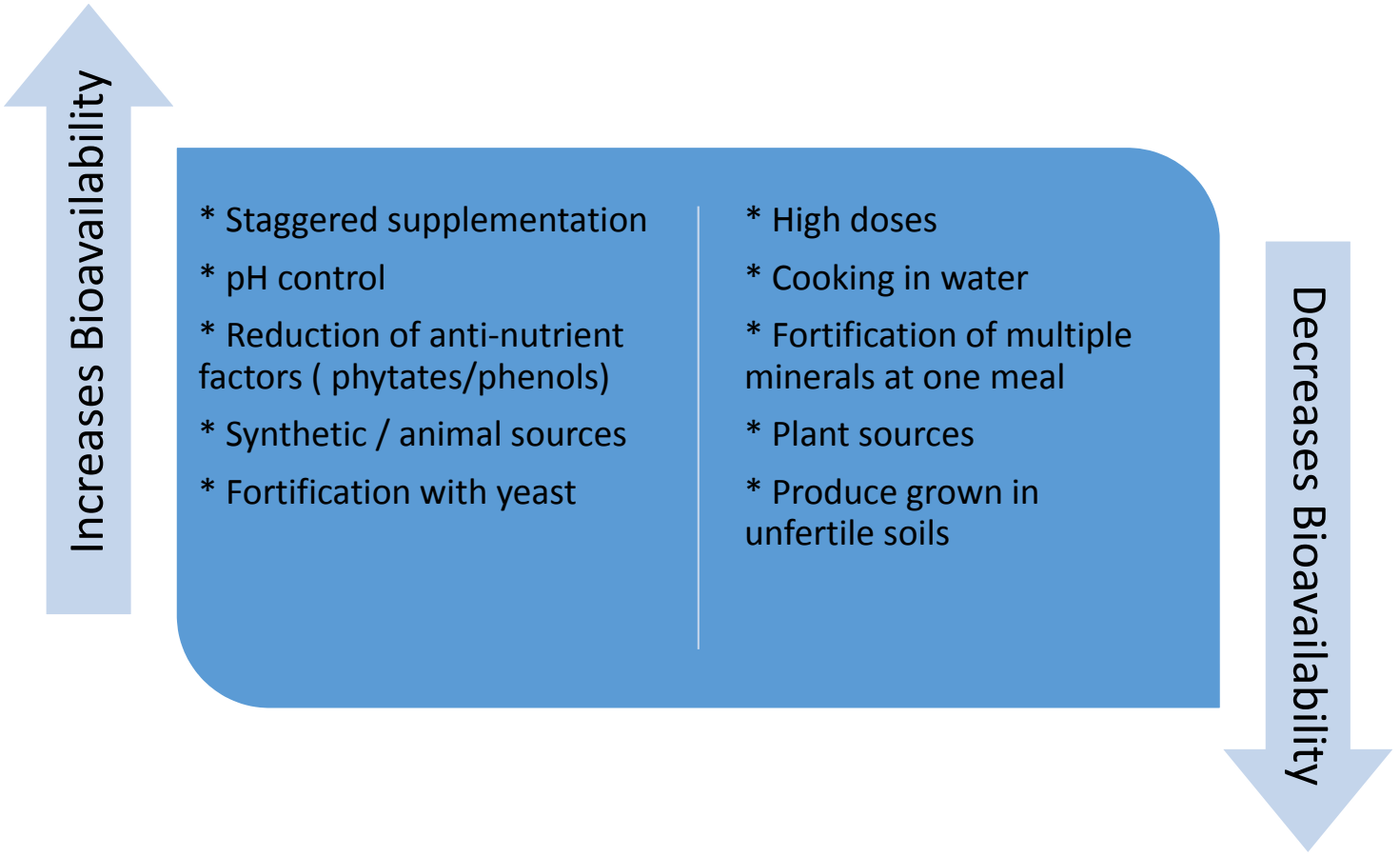
AFT Project Background

- Longer duration missions will require more nutrient dense foods
- Research conducted to optimize the bioavailability of foods to provide more efficient nutrition to future crews

Literature Review: Vitamin A, K, B9



Literature Review: Zinc /Copper/ Iron/ Manganese

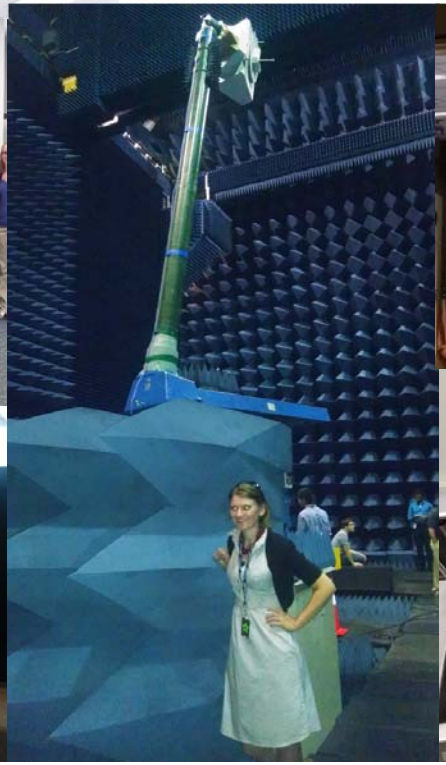


Overall recommendations to improve the nutrient density of flight food

- Identify specific meals for fortification of nutrients that benefit from the same processing parameters but do not compete for absorption
- Improve packaging to reduce oxidation risk
- Puree foods and minimize heat treatments
- Aim to provide more fortified foods
- Source produce from growing regions that produce nutrient rich foods

In Summary….

Thank you !!!



Thank you !!